Introduction: Understanding the Design Features of the Tri-State Science Assessment Targets

The development of the Tri-State Assessment Targets involved an integration of Unifying Themes/Big Ideas of Science and Statements of Enduring Knowledge for each domain of science.

A. Conceptual Matrix – Beginning with Unifying Themes/Big Ideas of Science

The conceptual matrix below served as an organizing tool for developing science assessment targets that address both the domain-specific core content of the Statements of Enduring Knowledge (found in Table 2) and the broader universal principles that integrate the different scientific disciplines - the Unifying Themes/Big Ideas of Science. Six Unifying Themes/Big Ideas of Science were chosen after an extensive review of the literature and are further described below in Table 1.

Table 1: Conceptual Matrix - Developing/Prioritizing Assessment Targets for Tri-State Science Assessment

Unifying Themes/Big Ideas of Science

(Subheadings under each Unifying Theme/Big Idea suggest but are not limited to what might be addressed)

Scientific Inquiry	**Nature of Science**	**Systems & Energy**	**Models & Scale**	**Patterns of Change**	**Form & Function**
• Collect data • Communicate understanding & ideas • Design, conduct, & critique investigations • Represent, analyze, & interpret data • Experimental design • Observe • Predict • Question and hypothesize • Use evidence to draw conclusions • Use tools, & techniques	• Accumulation of science knowledge (evidence & reasoning, looking at work of others) • Attitudes and dispositions of science (avoiding bias, divergent ideas, healthy skepticism) • History of Science • Science/Tech/ Society • Scientific Theories	• Cycles • Energy Transfer • Equilibrium • Interactions • Interdependence • Order & Organization	• Evidence provided through… • Explanations provided through… • Relative distance • Relative sizes *Models include - experimental models, simulations, & representations used to demonstrate abstract ideas*	• Constancy and Change • Cycles • Evolutionary Change	• Natural World

Tri-State Assessment Targets are written to:

(1) **be general** enough to allow for multiple potential test items/assessment tasks with varying cognitive demands addressing each assessment target; and (2) **have a cognitive demand (DOK) "ceiling"** generally consistent with (Webb's descriptions of) **Strategic Thinking** (Level 3) – requiring reasoning, planning, using/citing evidence, explaining/justifying thinking, drawing conclusions from data/observations, developing a logical argument for concepts, explaining phenomena in terms of concepts, or solving problems with more than one possible answer **OR Skills and Concepts** (Level 2) – classify, organize, make observations, compare data, explain relationships, describe examples/non-examples, interpret information.

B. Statements of Enduring Knowledge for Life Science, Earth/Space Science, and Physical Science

Tri-State Science Assessment Targets are organized into three science domains and further subdivided into 10 Statements of Enduring Knowledge (EK). Each Assessment Target is linked to one Statement of Enduring Knowledge, as indicated with the target's coding (e.g., LS1 means Life Science and the first EK statement, LS2 means Life Science and the second EK statement, etc.)

Statements of Enduring Knowledge (EK)…

- Are intended to identify the fundamental knowledge/concepts for each domain of science
- Cut across grade levels, so that learning is developmental/built upon across grades (although not all aspects of the EK may be addressed at all grade levels)
- Are of comparable grain size (and generally of a larger grain size than that of any single grade's stated expectations – Grade Level Expectation/GLE or Grade Span Expectation/GSE)
- Encompass, as a set, *the essential learning for each domain of science*
- Imply topics of study (and therefore, lead to focused instruction, as identified in science standards/GSEs/benchmarks)

C. The "Intersections" Create the Assessment Targets

Assessment Targets for high school, middle school, and elementary school were developed by applying the Unifying Themes/Big Ideas of science (listed in Table 1) to the Statements of Enduring Knowledge for each of the science domains of Life Science, Earth and Space Science, and Physical Science (listed in Table 2). **Not every Unifying Theme/Big Idea has an "intersection" with every Statement of Enduring Knowledge**. Development committees used prioritization strategies and field reviews to determine which assessment targets would provide the richest opportunities for large-scale assessment purposes.

Tri-State Science Assessment Targets are…

- Derived from and aligned with national and NH, RI, and VT's state science standards
- The "intersections" resulting from applying Unifying Themes/Big Ideas to Statements of Enduring Knowledge [e.g., What Systems & Energy concepts are essential to understanding LS1: All living organisms have identifiable structures and characteristics that allow for survival (organisms, populations, and species)?]
- Constructed with the understanding that not every Unifying Theme/Big Idea will have a meaningful "intersection" with every Statement of Enduring Knowledge
- General/broad enough to allow for multiple potential test items or assessment tasks with varying cognitive demands (Depth of Knowledge Levels)
- For the most part, written with an intended cognitive demand ceiling consistent with Depth of Knowledge (DOK) Levels 2 (Skills & Concepts) or 3 (Strategic Thinking) – based on the work of Norman L. Webb

Statements of Enduring Knowledge are intended to focus instruction and assessment on the essential learning for each domain of science. Table 2 lists the EK Statements for each domain of science and indicates the number of Tri-State Science Assessment Targets for each grade span, by domain and by EK content cluster**.**

Table 2: Number and Distribution of Science Assessment Targets by Grade Span				
Science Domain	**Statements of Enduring Knowledge (EK)**	**Elem K-4**	**Middle 5-8**	**High School 9-11**
Life Science	**LS 1** All living organisms have identifiable structures and characteristics that allow for survival (organisms, populations, and species).	**4**	**4**	**2**
	LS 2 Matter cycles and energy flows through an ecosystem.	**2**	**3**	**3**
	LS 3 Groups of organisms show evidence of change over time (structures, behaviors, and biochemistry).	**1**	**2**	**3**
	LS 4 Humans are similar to other species in many ways, and yet are unique among Earth's life forms.	**2**	**3**	**2**
	Life Science Totals	**9**	**12**	**10**
Earth & Space Science	**ESS 1** The Earth and earth materials as we know them today have developed over long periods of time, through continual change processes.	**6**	**5**	**4**
	ESS 2 The earth is part of a solar system, made up of distinct parts that have temporal and spatial interrelationships.	**0**	**3**	**0**
	ESS 3 The origin and evolution of galaxies and the universe demonstrate fundamental principles of physical science across vast distances and time	**0**	**0**	**4**
	Earth/Space Science Totals	**6**	**8**	**8**
Physical Science	**PS 1** All living and nonliving things are composed of matter having characteristic properties that distinguish one substance from another *(independent of size or amount of substance)*	**3**	**5**	**4**
	PS 2 Energy is necessary for change to occur in matter. Energy can be stored, transferred and transformed, but cannot be destroyed.	**3**	**2**	**3**
	PS 3 The motion of an object is affected by forces.	**2**	**1**	**3**
	Physical Science Totals	**8**	**8**	**10**
Total Tri-State Science Assessment Targets		**23**	**28**	**28**

D. The Format and Meaning of Assessment Target Coding

Each Assessment Target contains a code before the narrative text of the target. These codes identify the specific Statement of Enduring Knowledge, the grade span, the connections to one or more Unifying Theme/Big Idea, and finally the target number.

Table 3 illustrates an example: **LS1 (K-4) INQ+POC –1** means that this target addresses the first Life Science EK statement (**LS1**); the (**K-4**) grade span; is linked to Unifying Themes/Big ideas of Inquiry (**INQ**) and Patterns of Change (**POC**); and is the first assessment target listed **(1**) under the domain of Life Science. Some targets address only one Unifying Theme and others address more than one.

Table 3 Sample Target Coding

LS1 – All living organisms have identifiable structures and characteristics that allow for survival (organisms, populations, and species)

Elementary Target	Middle School Target	High School Target
LS1 (K-**4) INQ+POC –1** Sort/classify different living things using similar and different characteristics. Describe why organisms belong to each group or cite evidence about how they are alike or not alike.	LS1 (5-**8**) – INQ+ SAE- **1** Using data and observations about the biodiversity of an ecosystem make predictions or draw conclusions about how the diversity contributes to the stability of the ecosystem.	LS1 (9-**11**) INQ+SAE+FAF -**1** Use data and observation to make connections between, to explain, or to justify how specific cell organelles produce/regulate what the cell needs or what a unicellular or multi-cellular organism needs for survival (e.g., protein synthesis, DNA-replication, nerve cells)

Assessment Target numbering is consecutive within each domain of science for each grade span. For example, at grades K-4, Life Science targets are numbered 1 though 9 (beginning with LS1, then continuing with LS2, LS3, and LS4); Physical Science targets begin the numbering again with 1 through 8 for PS1, PS2 and PS3; and Earth/Space Science targets again begin numbering 1- 6.

While the Statements of Enduring Knowledge are the same across all grade spans, the set of related targets within a grade span *do not address all aspects of the EK Statement.* This was done intentionally to focus instruction and assessment on the essential learning for the grade span, as well as on the developmentally appropriate concepts and skills. For example, at the elementary grade span, LS1 will focus on organisms and external structures, while the middle school grade span will move to internal structures and include organisms and populations. **Local science GSEs/GCEs** address foundational knowledge and skills not included in assessment targets at a particular grade span, as well as areas of science learning that extend knowledge or are better assessed without constraints on time, materials, contexts, or learning environments (e.g., such as conducting a field study or researching a topic of interest).

LS 1 **All living organisms have identifiable structures and characteristics that allow for survival (organisms, populations, & species).**		
Elementary	**Middle**	**High School**
LS1 (K-**4**) INQ+POC –**1** Sort/classify different living things using similar and different characteristics. Describe why organisms belong to each group or cite evidence about how they are alike or not alike	LS1 (5-**8**) INQ+ SAE- **1** Using data and observations about the biodiversity of an ecosystem make predictions or draw conclusions about how the diversity contributes to the stability of the ecosystem	LS1 (9-**11**) INQ+SAE+FAF -**1** Use data and observation to make connections between, to explain, or to justify how specific cell organelles produce/regulate what the cell needs or what a unicellular or multi-cellular organism needs for survival (e.g., protein synthesis, DNA replication, nerve cells)
LS1 **(**K-**4)** SAE -**2** Identify the basic needs of plants and animals in order to stay alive. (i.e., water, air, food, space)	LS1 (5-**8**) SAE+FAF –**2** Describe or compare how different organisms have mechanisms that work in a coordinated way to obtain energy, grow, move, respond, provide defense, enable reproduction, or maintain internal balance (e.g., cells, tissues, organs and systems)	LS1 (9-**11**) FAF+ POC -**2** Explain or justify with evidence how the alteration of the DNA sequence may produce new gene combinations that make little difference, enhance capabilities, or can be harmful to the organism (e.g., selective breeding, genetic engineering, mutations)
LS1 (K-**4**) POC –**3** Predict, sequence or compare the life stages of organisms – plants and animals (e.g., put images of life stages of an organism in order, predict the next stage in sequence, compare two organisms)	LS1 (5-**8**) POC -**3** Compare and contrast sexual reproduction with asexual reproduction.	
LS1 (K-**4**) FAF –**4** Identify and explain how the physical structures of an organism (plants or animals) allow it to survive in its habitat/environment (e.g., roots for water; nose to smell fire)	LS1 (5-**8**) FAF –**4** Explain relationships between or among the structure and function of the cells, tissues, organs, and organ systems in an organism	

LS 2 **Matter cycles and energy flows through an ecosystem.**		
Elementary	**Middle**	**High School**
LS2 (K-**4**) SAE –**5** Recognize that energy is needed for all organisms to stay alive and grow or identify where a plant or animal gets its energy	LS2 (5-**8**) INQ+SAE -**5** Using data and observations, predict outcomes when abiotic/biotic factors are changed in an ecosystem	LS2 (9-**11**) INQ+SAE -**3** Using data from a specific ecosystem, explain relationships or make predictions about how environmental disturbance (human impact or natural events) affects the flow of energy or cycling of matter in an ecosystem
LS2 (K-**4**) SAE –**6** Describe ways plants and animals depend on each other (e.g., shelter, nesting, food)	LS2 (5-**8**) SAE –**6** Given a scenario, trace the flow of energy through an ecosystem, beginning with the sun, through organisms in the food web, and into the environment (includes photosynthesis and respiration)	LS2 (9-**11**) POC+ SAE –**4** Trace the cycling of matter (e.g., carbon cycle) and the flow of energy in a living system from its source through its transformation in cellular, biochemical processes (e.g., photosynthesis, cellular respiration, fermentation)
	LS2 (5-**8**) SAE-**7** Given an ecosystem, trace how matter cycles among and between organisms and the physical environment (includes water, oxygen, food web, decomposition, recycling but **not** carbon cycle or nitrogen cycle)	LS2 (9-**11**) NOS –**5** Explain or evaluate potential bias in how evidence is interpreted in reports concerning a particular environmental factor that impacts the biology of humans

NH RI VT - Science Assessment Targets for All Grade Spans

LS 3 **Groups of organisms show evidence of change over time (structures, behaviors, and biochemistry).**		
Elementary	**Middle**	**High School**
LS3 (K-**4**) SAE –**7** Using information (data or scenario), explain how changes in the environment can cause organisms to respond (e.g., survive there and reproduce, move away, die)	LS3 (5-**8**) MAS+FAF – **8** Use a model, classification system, or dichotomous key to illustrate, compare, or interpret possible relationships among groups of organisms (e.g., internal and external structures, anatomical features)	LS3 (9-**11**) NOS -**6** Explain how evidence from technological advances supports or refutes the genetic relationships among groups of organisms (e.g., DNA analysis, protein analysis)
	LS3 (5-**8**) POC-**9** Cite examples supporting the concept that certain traits of organisms may provide a survival advantage in a specific environment and therefore, an increased likelihood to produce offspring	LS3 (9-**11**) INQ +POC-**7** Given a scenario, provide evidence that demonstrates how sexual reproduction results in a great variety of possible gene combinations and contributes to natural selection (e.g., Darwin's finches, isolation of a species, Tay Sach's disease)
		LS3 (9-**11**) INQ +FAF+POC -**8** Given information about living or extinct organisms, cite evidence to explain the frequency of inherited characteristics of organisms in a population, OR explain the evolution of varied structures (with defined functions) that affected the organisms' survival in a specific environment (e.g., giraffe, wind pollination of flowers)
LS 4 Humans are similar to other species in many ways, and yet are unique among Earth's life forms.		
Elementary	**Middle**	**High School**
LS4 (K-**4**) FAF -**8** Identify what the physical structures of humans do (e.g., sense organs – eyes, ears, skin, etc.) or compare physical structures of humans to similar structures of animals	LS4 (5-**8**) INQ-**10** Use data and observations to support the concept that environmental or biological factors affect human body systems (biotic & abiotic)	LS4 (9-**11**) INQ+ NOS-**9** Use evidence to make and support conclusions about the ways that humans or other organisms are affected by environmental factors or heredity (e.g., pathogens, diseases, medical advances, pollution, mutations)
LS4 (K-**4**) POC -**9** Distinguish between characteristics of humans that are inherited from parents (i.e., hair color, height, skin color, eye color) and others that are learned (e.g., riding a bike, singing a song, playing a game, reading)	LS4 (5-**8**) INQ+POC-**11** Using data provided, select evidence that supports the concept that genetic information is passed on from both parents to offspring	LS4 (9-**11**) SAE+FAF -**10** Explain how the immune system, endocrine system, or nervous system works and draw conclusions about how systems interact to maintain homeostasis in the human body
	LS4 (5-**8**) POC-**12** Describe the major changes that occur over time in human development from single cell through embryonic development to new born (i.e., trimesters: 1st – group of cells, 2nd - organs form, 3rd - organs mature)	
TOTALS for LS = 9	**TOTALS for LS = 12**	**TOTALS for LS = 10**

PS 1 **All living and nonliving things are composed of matter having characteristic properties that distinguish one substance from another (independent of size or amount of substance)**		
Elementary	**Middle**	**High School**
PS1 (K-**4**) INQ –**1** Collect and organize data about physical properties in order to classify objects or draw conclusions about objects and their characteristic properties (e.g., temperature, color, size, shape, weight, texture, flexibility)	PS1 (5-**8**) INQ -**1** Investigate the relationships among mass, volume and density	PS1 (9-**11**) INQ –**1** Use physical and chemical properties as determined through an investigation to identify a substance
PS1 (K-**4**) POC –**2** Make a prediction about what might happen to the state of common materials when heated or cooled or categorize materials as solid, liquid, or gas	PS1 (5-**8**) INQ+POC –**2** Given data about characteristic properties of matter (e.g., melting and boiling points, density, solubility) identify, compare, or classify different substances	PS1 (9-**11**) MAS+ NOS –**2** Scientific thought about atoms has changed over time. Using information (narratives or models of atoms) provided, cite evidence that has changed our understanding of the atom and the development of atomic theory
PS1 (K-**4**) SAE –**3** Use measures of weight (data) to demonstrate that the whole equals the sum of its parts	PS1 (5-**8**) INQ+SAE -**3** Collect data or use data provided to infer or predict that the total amount of mass in a closed system stays the same, regardless of how substances interact (conservation of matter)	PS1 (9-**11**) POC -**3** Explain how properties of elements and the location of elements on the periodic table are related.
	PS1 (5-**8**) SAE+MAS – **4** Represent or explain the relationship between or among energy, molecular motion, temperature, and states of matter	PS1 (9-**11**) MAS+FAF – **4** Model and explain the structure of an atom or explain how an atom's electron configuration, particularly the outermost electron(s), determines how that atom can interact with other atoms
	PS1 (5-**8**) MAS –**5** Given graphic or written information, classify matter as atom/molecule or element/compound (Not the structure of an atom)	

PS 2 **Energy is necessary for change to occur in matter. Energy can be stored, transferred, and transformed, but cannot be destroyed.**		
Elementary	**Middle**	**High School**
PS2 (K-**4**) SAE -**4** Given a specific example or illustration (e.g., simple closed circuit, rubbing hands together), predict the observable effects of energy (i.e., light bulb lights, a bell rings, hands warm up) (E.g., a test tem might ask, "what will happen when…?")	PS2 (5-**8**) SAE+POC- **6** Given a real-world example, show that within a system, energy transforms from one form to another (i.e., chemical, heat, electrical, gravitational, light, sound, mechanical)	PS2 (9-**11**) POC+SAE -**5** Demonstrate how transformations of energy produce some energy in the form of heat and therefore the efficiency of the system is reduced (chemical, biological, and physical systems)
PS2 (K-**4**) SAE – **5** Use observations of light in relation to other objects/substances to describe the properties of light (can be reflected, refracted, or absorbed)	PS2 (5-**8**) INQ+SAE+POC – **7** Use data to draw conclusions about how heat can be transferred (convection, conduction, radiation)	PS2 (9-**11**) INQ+SAE -**6** Using information provided about chemical changes, draw conclusions about and explain the energy flow in a given chemical reaction (e.g., exothermic reactions, endothermic reactions)
PS2 (K-**4**) INQ+SAE –**6** Experiment, observe, or predict how heat might move from one object to another		PS2 (9-**11**) SAE – **7** Explain relationships between and among electric charges, magnetic fields, electromagnetic forces, and atomic particles.
PS 3 The motion of an object is affected by forces.		
PS3 (K-**4**)-INQ+SAE –**7** Use data to predict how a change in force (greater/less) might affect the position, direction of motion, or speed of an object (e.g., ramps and balls)	PS3 (5-**8**) INQ+ POC –**8** Use data to determine or predict the overall (net) effect of multiple forces (e.g., friction, gravitational, magnetic) on the position, speed, and direction of motion of objects.	PS3 (9-**11**) INQ+POC -**8** Given information (e.g., graphs, data, diagrams), use the relationships between or among force, mass, velocity, momentum, acceleration to predict and explain the motion of objects
PS3 (K-**4**) INQ+ SAE –**8** Use observations of magnets in relation to other objects to describe the properties of magnetism (i.e., attract or repel certain objects or has no effect)		PS3 (9-11) POC –**9** Apply the concepts of inertia, motion, and momentum to predict and explain situations involving forces and motion, including stationary objects and collisions.
		PS3 (9-**11**) SAE –**10** Explain the effects on wavelength and frequency as electromagnetic waves interact with matter (e.g., light diffraction, blue sky)
TOTALS for PS = 8	**TOTALS for PS = 8**	**TOTALS for PS = 10**

ESS 1 **The Earth and earth materials as we know them today have developed over long periods of time, through continual change processes.**		
Elementary	**Middle**	**High School**
ESS1 (K-**4**) INQ –**1** Given certain earth materials (soils, rocks or minerals) use physical properties to sort, classify, and describe them	ESS1 (5-**8**) INQ+POC –**1** Use geological evidence provided to support the idea that the Earth's crust/lithosphere is composed of plates that move	ESS1 (9-**11**) INQ+POC– **1** Provided with geologic data (including movement of plates) on a given locale, predict the likelihood for an earth event (e.g., volcanoes, mountain ranges, islands, earthquakes, tides)
ESS1 (K-**4**) INQ –**2** Use results from an experiment to draw conclusions about how water interacts with earth materials (e.g., percolation, erosion, frost heaves)	ESS1 (5-**8**) SAE–**2** Explain the processes that cause the cycling of water into and out of the atmosphere and their connections to our planet's weather patterns.	ESS1 (9-**11**) NOS–**2** Trace the development of the theory of plate tectonics or provide supporting geologic/geographic evidence that supports the validity of the theory of plate tectonics
ESS (K-**4**) NOS –**3** Explain how the use of scientific tools helps to extend senses and gather data about weather. (i.e., weather/wind vane: direction; wind sock: wind intensity; anemometer: speed; thermometer: temperature; meter sticks/rulers: snow depth; rain gauges: rain amount in inches)	ESS1 (5-**8**) POC –**3** Explain how earth events (abruptly and over time) can bring about changes in Earth's surface: landforms, ocean floor, rock features, or climate	ESS1 (9-**11**) SAE+POC–**3** Explain how internal and external sources of heat (energy) fuel geologic processes (e.g., rock cycle, plate tectonics, sea floor spreading)
ESS1 (K-**4**) INQ+SAE –**4** Explain how wind, water, or ice shape and reshape the earth	ESS1 (5-**8**) SAE+POC –**4** Explain the role of differential heating or convection in ocean currents, winds, weather and weather patterns, atmosphere, or climate	ESS1 (9-**11**) INQ+POC+MAS—**4** Relate how geologic time is determined using various dating methods (e.g. radioactive decay, rock sequences, fossil records)
ESS1 (K-**4**) POC –**5** Based on data collected from daily weather observations, describe weather changes or weather patterns	ESS1 (5-**8**) INQ+POC -**5** Using data about a rock's physical characteristics make and support an inference about the rock's history and connection to rock cycle	
ESS1 (K-**4**) FAF -**6** Given information about earth materials explain how their characteristics lend themselves to specific uses		

ESS 2 **The Earth is part of a solar system, made up of distinct parts that have temporal and spatial interrelationships.**		
Elementary	**Middle**	**High School**
	ESS2 (5-**8**) MAS -**6** Compare and contrast planets based on data provided about size, composition, location, orbital movement, atmosphere, or surface features (includes moons).	
	ESS2 (5-**8**) NOS -**7** Explain how technological advances have allowed scientists to re-evaluate or extend existing ideas about the solar system	
	ESS2 (5-**8**) SAE+ POC -**8** Explain temporal or positional relationships between or among the Earth, sun, and moon (e.g., night/day, seasons, year, tides) OR how gravitational force affects objects in the solar system (e.g., moons, tides, orbits, satellites)	

ESS 3 **The origin and evolution of galaxies and the universe demonstrate fundamental principles of physical science across vast distances and time**		
Elementary	**Middle**	**High School**
		ESS3 (9-**11**) NOS–**5** Explain how scientific theories about the structure of the universe have been advanced through the use of sophisticated technology (e.g., space probes; visual, radio and x-ray telescopes)
		ESS3 (9-**11**) NOS–**6** Provide scientific evidence that supports or refutes the "Big Bang" theory of how the universe was formed
		ESS3 (9-**11**) SAE–**7** Based on the nature of electromagnetic waves, explain the movement and location of objects in the universe or their composition (e.g., red shift, blue shift, line spectra)
		ESS3 (9-**11**) POC+SAE–**8** Explain the relationships between or among the energy produced from nuclear reactions, the origin of elements, and the life cycle of stars
TOTAL ESS = 6	**TOTAL ESS = 8**	**TOTAL ESS = 8**